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The Aboral Nervous System of *Marsupiocrinus* Morris

C. R. C. Paul

Assistant Professor of Geology, Indiana University Northwest

Almost nothing is known about the nerve systems of fossil crinoids and little more about those of recent species. Hence any new information, particularly from fossil crinoids, is of special interest. This note describes an unusual structure which may have been part of the aboral nerve system of a Silurian crinoid, *Marsupiocrinus*. The crinoid specimen in question (FMNH P11945) comes from Niagaran strata (probably the Brownsport Formation) of Decatur County, Tennessee. The calyx is fairly complete although silicified. Silicification has not completely destroyed the original meshwork structure of the plates which can be detected in some areas when the plates are wet. The plates are either deeply weathered or were split irregularly when the specimen broke free of its matrix. In either case the effect has been to reveal an unusual branching structure which was entirely within the calycal plates in life. The aboral position of the structure *within* the calycal plates suggests that it may well have been part of the aboral nerve system. However, the structure is radically different from that of the aboral nerve systems of recent crinoids.

I am grateful to Dr. Eugene S. Richardson, Jr. for the loan of the specimen of *Marsupiocrinus* and to Drs. Bernd-Dietrich Erdtmann and Thomas G. Perry for their opinions on the possible graptolite or bryozoan affinities of the structure described here.

Description.—The calyx is bowl-shaped, about 40 mm. in diameter and, despite the fracturing or weathering, outlines of three basal, five radial, two inter-radial, and several brachial plates can be distinguished (cf. figs. 1, 4). The position of the azygous basal allows the calyx to be oriented. In the A and B radii there is a delicate

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FIG. 1. Stereo-photographs of *Marsupiocrinus* sp. (FMNH P11945) to show supposed aboral nerve system, × 2. Lightly coated with ammonium chloride sublimate.

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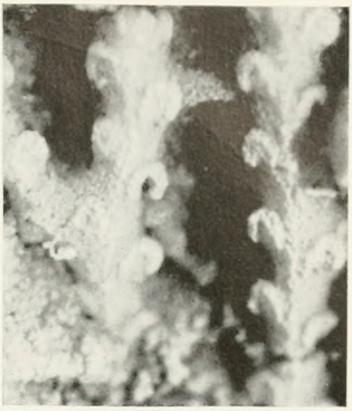

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FIGS. 2–3. Details of supposed aboral nerve system in *Marsupiocrinus* sp. (FMNH P11945). Fig. 2, × 17.5; fig. 3, × 35. Both lightly coated with ammonium chloride sublimate.

branching structure. It is incompletely exposed and cannot be detected in other radii. As far as can be determined from the portion preserved, there is a zig-zag main branch within the basal plate in an inter-radial position. This zig-zag branch gives off lateral branches to the A and B radii alternately. Within each radius the branches are approximately parallel and they bifurcate a short distance from the inter-radial branch. Each branch has a median ridge or keel and is crenulate with short curved ridges or processes which alternate on either side (figs. 2–3, 5). In several places narrow cross members are preserved which connect adjacent branches and have narrow keels (figs. 2, 5). There is a cross member developed for each five or six pairs of curved processes along a branch and this gives the structure a superficial resemblance to a fenestrate bryozoan or a dendroid graptolite. Near the radial-basal sutures the structure is still buried within the plates. In one place the structure can be traced within the plates when the calyx is wet and there is no doubt that it is entirely surrounded by the meshwork of the plates. In the radial plates of the A and B radii further portions of the structure are exposed. In the A radius there are several parallel branches all directed radially and five of which bifurcate before reaching the distal edge of the preserved portion of the structure. Proximally, the branches are broken off and there is no indication of the aboral nerve center nor of the chambered organ.

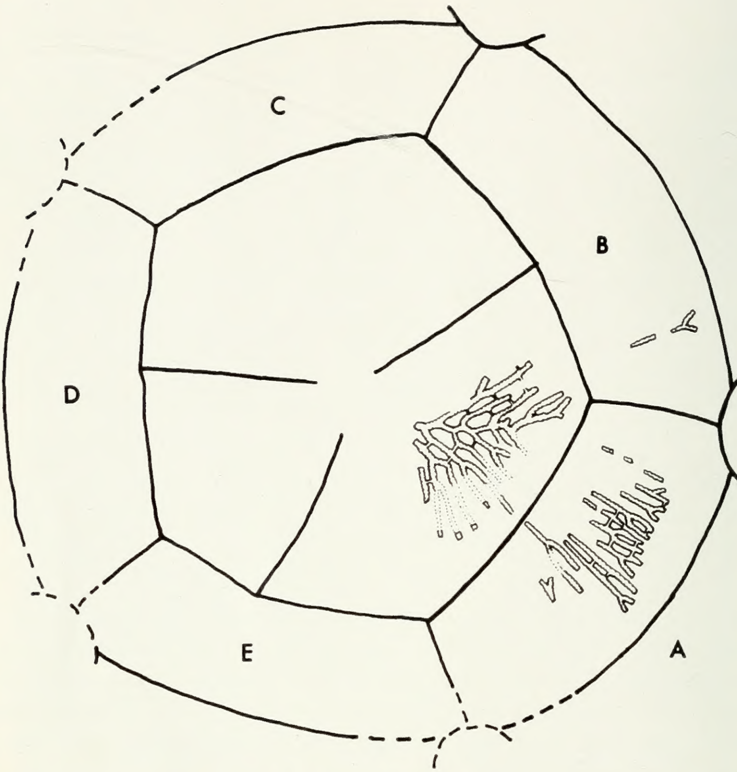


FIG. 4. Outline drawing of plates of *Marsupiocrinus* sp. (FMNH P11945) to show relationship of supposed aboral nerve system to plates. A–E: radii.

The main branches of the structure reach 0.40–0.43 mm. in width (including the curved processes); and the cross members 0.10–0.13 mm. There are 10–12 pairs of curved processes in 5 mm. along a main branch. The preserved portion of the structure is 15 mm. long from proximal to distal end in the A radius and 17 mm. in the B radius.

Remarks.—Despite its superficial resemblance to a dendroid graptolite rhabdosome or a fenestrate bryozoan zoarium, the fossil structure in *Marsupiocrinus* differs in important details from either. In particular, the mode of branching is unlike that of any fenestrate bryozoan or dendroid graptolite. Among graptolites proper, only *Goniograptus* has a similar structure of alternating branches but this genus lacks anything to correspond to the cross members of the crinoid structure. The curved processes are not apertures such as would appear on a bryozoan or graptolite and *Goniograptus* has aper-

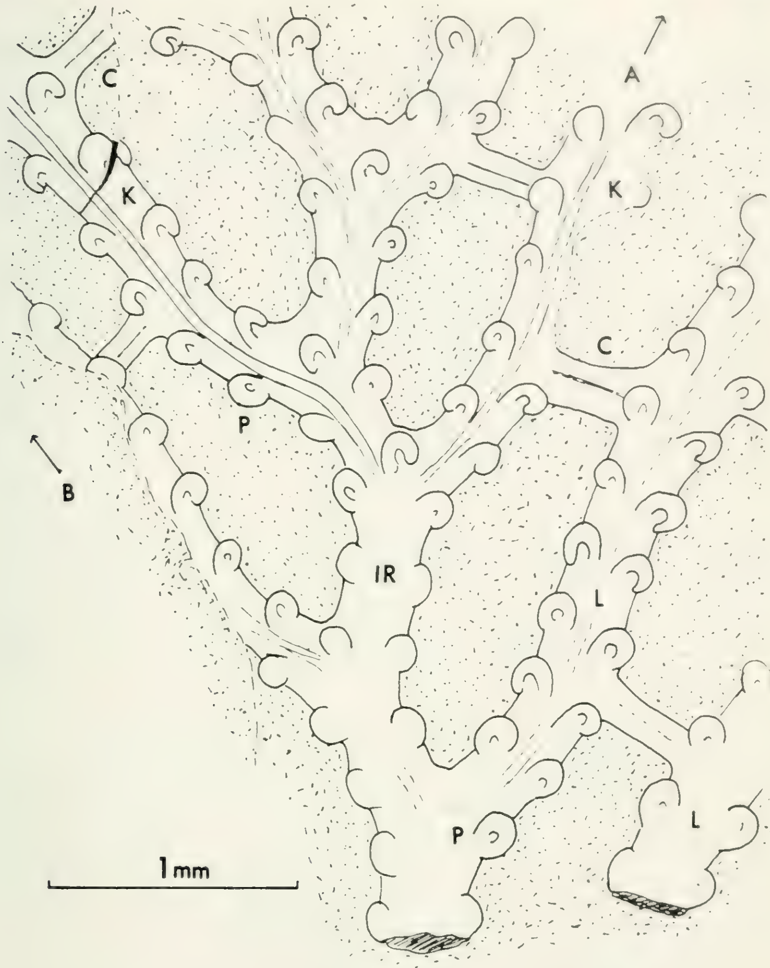


FIG. 5. Camera lucida drawing of a small area of supposed aboral nerve system in *Marsupiocrinus* sp. A, B directions of radii A, B; C, cross member; IR, zigzag inter-radial branch; K, keel; L, lateral branches; P, curved processes.

tures on one side of each stipe whereas the curved processes are developed on both sides of a branch. Quite apart from these considerations it is impossible to imagine how a graptolite or bryozoan could become preserved within the calycal plates of a crinoid and there is no doubt that the structure is within the plates of *Marsupiocrinus*. The structure is much too regular to have been produced by a burrowing organism. Silicification has not destroyed the original calcite cleavage and

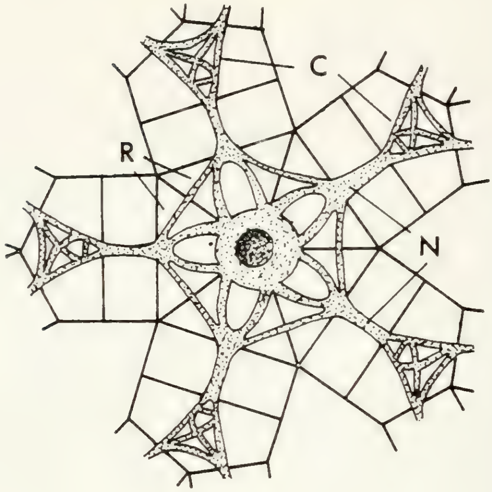


FIG. 6. Diagrammatic representation of aboral nerve system in *Antedon* as seen in plan view (after Cuénot, 1948, fig. 53). C, chiasmata; N, nerve strands; R, radial plates.

both the fossil structure and the surrounding plates "flash" when held at a suitable angle to a light source. Undoubtedly, the structure is part of the crinoid.

Among recent crinoids the only organ system developed within the plates of the calyx is the aboral nerve system. Crinoids have three more or less separate nerve systems of which the aboral is centered on the base of the calycal cavity at the top of the stem and is the main motor system concerned with orientation and movement. Most knowledge of the aboral nerve system in recent crinoids is based on studies of *Antedon*, a free-swimming comatulid crinoid. This is very unfortunate from a paleontological point of view since *Antedon* is a highly specialized crinoid with an atypical calycal structure. The aboral nerve system of *Antedon* was described by Hamann (1889) and has been refigured recently by Cuénot (1948), Hyman (1955), and Nichols (1962). It consists of an aboral center which gives off branches to the cirri aborally. Laterally, five main branches pass outward, immediately bifurcate, and join a pentagonal ring of nerve tissue *within* the radial plates (fig. 6). The five main branches are radial. Distal to the pentagonal ring the main branches pass into the arm plates and divide in a chiasma with each division of the arms. This structure is very much simpler than the fossil structure. There is nothing to correspond to the curved processes nor to the cross

members, the five main branches are radial not inter-radial, and no plate has more than two nerve trunks within it.

Antedon is a highly specialized, free-swimming crinoid which lacks a stem in the adult form and has a modified calyx. The calyx plates are reduced and, with the centro-dorsal, form a capsule which entirely surrounds the aboral nerve center and chambered organ. The basal plates are fused into a rosette which is adoral to the aboral nerve center– a most unexpected position. In view of these specializations it seems unlikely that the aboral nerve system of *Antedon*, or other comatulids, is typical of crinoids in general. In particular, the free-swimming mode of life requires considerable co-ordination ability and modifications to the main motor nerve system might be expected in such a case. However, no greater similarity is revealed by comparing the fossil structure with published descriptions of the aboral nerve system in recent stalked crinoids. The figures given by Bather (1900) and Reichensperger (1905) indicate a very simple structure usually with a single nerve trunk passing from plate center to plate center within the plates (figs. 7–9). Reichensperger studied *Neocrinus decorus* which has an aboral nerve system basically the same as that of *Antedon* but which differs in having a

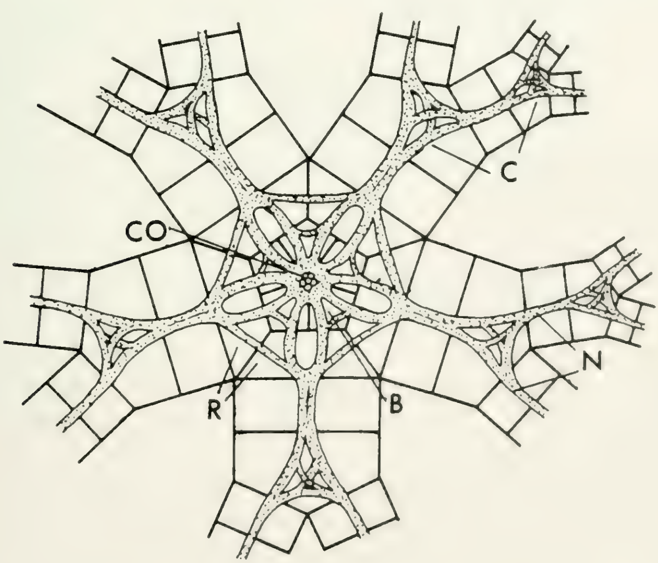
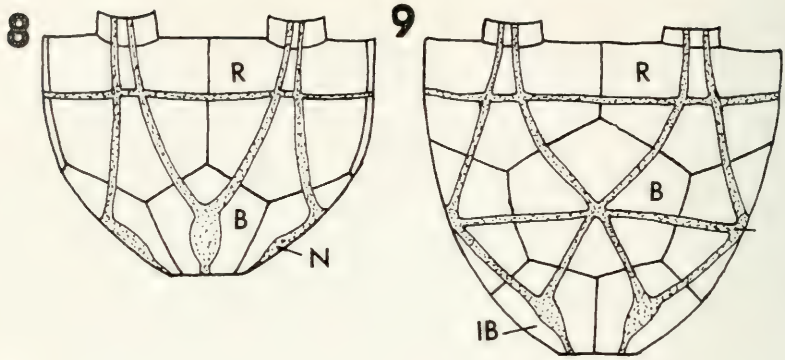


FIG. 7. Diagrammatic representation of aboral nerve system in *Neocrinus decorus* in plan view (after Reichensperger, 1905, p. 26). B, basal plate; C, chiasmata; CO, chambered organ; N, nerve strands; R, radial plates.



FIGS. 8–9. Diagrammatic lateral views of aboral nerve systems in mono- and dicyclic crinoids (after Bather, 1900, fig. 12). B, basal plates; IB, infra-basal plates; N, nerve strands; R, radial plates.

partial ring of nerve tissue within the basal plates and slightly different chiasmata (cf. figs. 6–7). Measurements given by Reichensperger indicate that the nerve strands of *Neocrinus decorus* are approximately half the diameter or less of the branches in the fossil structure. Unfortunately, Bather gives no source for his diagrams.

Marsupiocrinus belongs to an extinct order, the Camerata, while all living crinoids are articulates. Camerates generally have a large, well-developed calyx into which some arm plates are usually incorporated. It is conceivable that the large calyx plates of camerates required a more complex nervous system within them. In articulates the calyx is frequently reduced and individual plates are small. Such reduction in size may account for the simplicity in the structure of the aboral nerve system of articulates. The fact that the aboral nerve system controls posture and movement by innervating muscles —rather than being primarily sensory—argues against this suggestion since there are no muscles within the calyceal plates of either order. Ramifying, anastomosing structures like that of *Marsupiocrinus* are better adapted to a general sensory function. Perhaps the aboral nerve system in camerates such as *Marsupiocrinus* also had a sensory function.

To conclude, the fossil structure preserved in *Marsupiocrinus* is an integral part of the crinoid and, since it is within the calyx plates, it is tentatively interpreted as part of the aboral nerve system. The structure in *Marsupiocrinus* is so different from that of the aboral nerve systems of recent crinoids as to suggest either *1*) that it represents some other organ system not found in recent crinoids or *2*) that

the function of the aboral nerve system was not exactly the same in fossil camerates as it is in recent articulate crinoids.

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